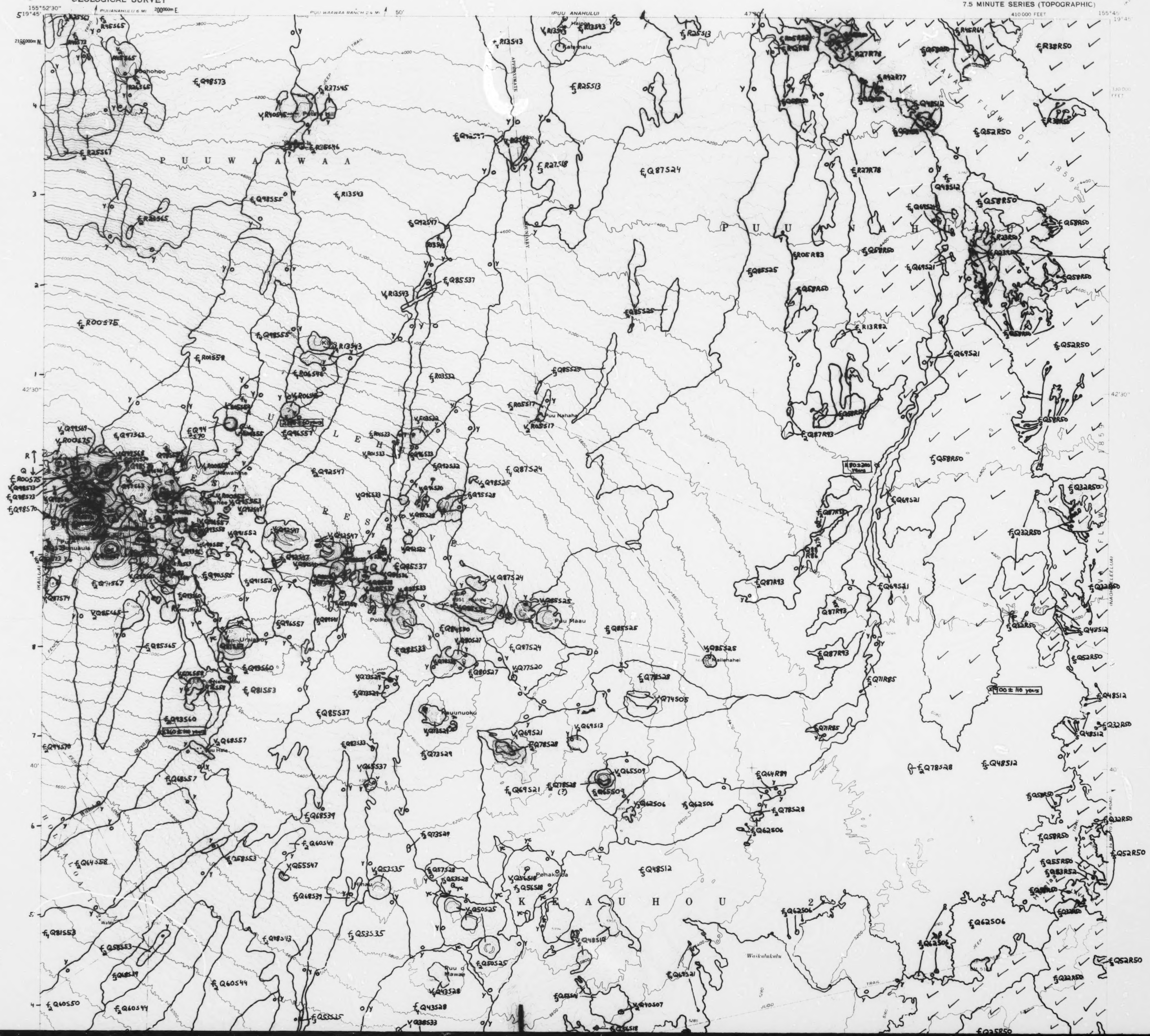
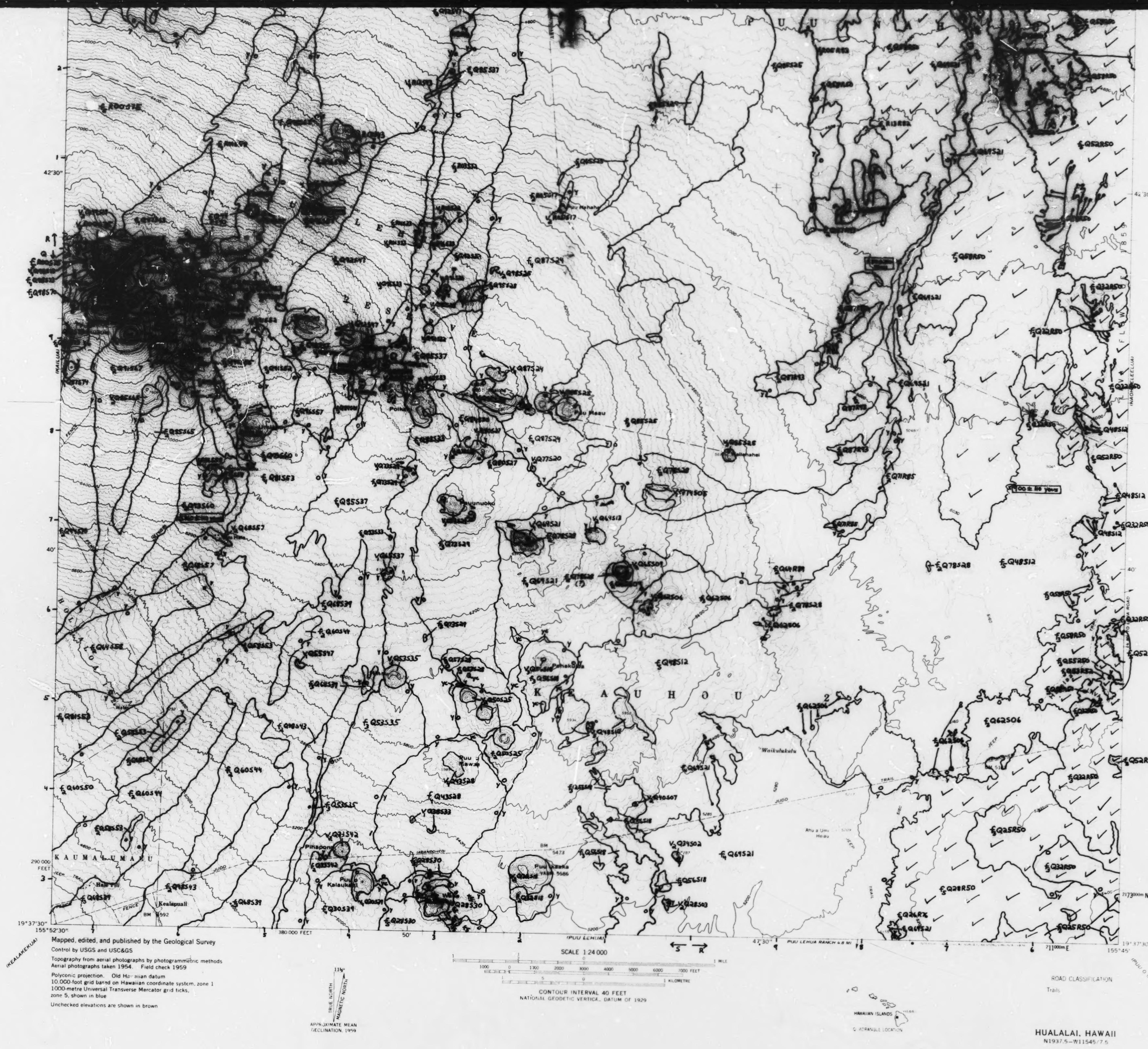
DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

OPEN-FILE REPORT
86-270
SHEET 1 OF 2

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

HUALALAI QUADRANGLE
HAWAII—HAWAII CO.
ISLAND OF HAWAII—NORTH KONA DISTRICT
7.5 MINUTE SERIES (TOPOGRAPHIC)





Mapped, edited, and published by the Geological Survey

Control by USGS and USC&GS

Topography from aerial photographs by photogrammetric methods
Aerial photographs taken 1954. Field check 1959

Polyconic projection. Old Hawaiian datum
10,000-foot grid based on Hawaiian coordinate system, zone 1
1000-metre Universal Transverse Mercator grid ticks,
zone 5, shown in blue

Unchecked elevations are shown in brown

See Sheet 2 for explanation

[redacted]

This report is preliminary and has
not been reviewed for conformity
with U.S. Geological Survey editorial
standards and stratigraphic nomenclature.

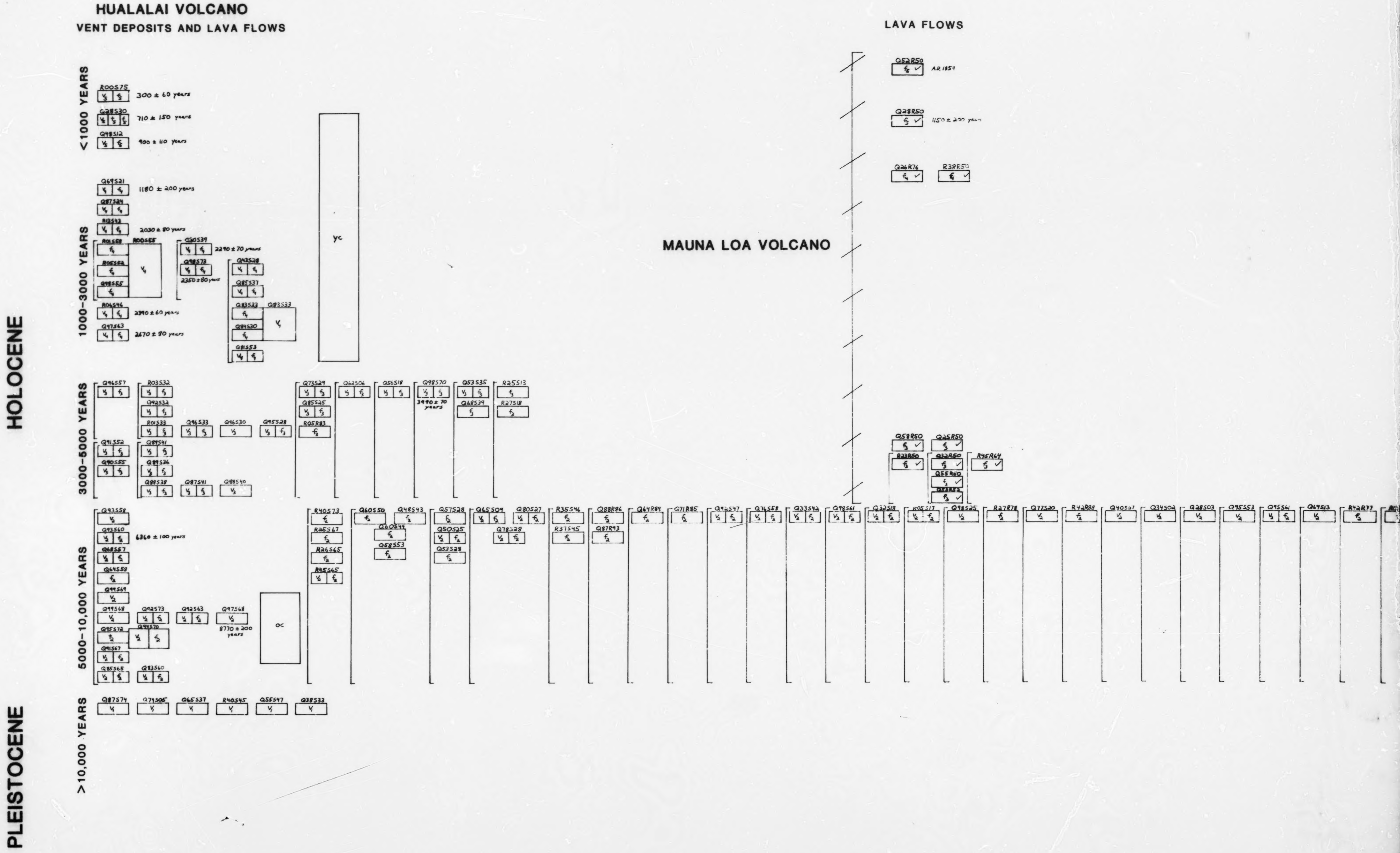
PRELIMINARY GEOLOGIC MAP OF THE HUALALAI QUADRANGLE, HAWAII

by Richard B. Moore, Frank A. Trusdell, David A. Clague, and Wendy A. Bohrson

1986

DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

CORRELATION OF MAP UNITS



GEOLOGIC SUMMARY

The Hualalai quadrangle includes the summit of Hualalai Volcano, most of its major south-southeast-trending rift zone, and most of its diffuse north-trending rift zone. The rift zones are marked by steep-sided spatter and cinder cones and a few satellitic shields; open cracks and normal faults, prominent on Kilauea and Mauna Loa Volcanoes, are virtually absent. Eleven tholeiitic basalt flows from Mauna Loa Volcano cover the eastern ten percent of the quadrangle, where they are interbedded with alkali olivine basalt flows of Hualalai. Most of the area is relatively arid, receiving less than 80 cm of rain per year, although fog is common.

Trachytes occur as xenoliths in three basaltic cinder deposits; they generally are aphyric in hand specimen, but microscopy indicates that nepheline and sodalite microphenocrysts are present in some samples.

DESCRIPTION OF MAP UNITS

HUALALAI VOLCANO

UNITS LESS THAN 1,000 YEARS OLD

UNITS 1,000-3,000 YEARS OLD

Q69521	Spatter deposits and pahoehoe and aa flows in the south-central part of the map. Initial high fountaining distributed basaltic cinders and abundant small (up to 5 cm) xenoliths of trachyte over a large area (perhaps in excess of 50 km², indicating that the eruption was sub-Plinian). Subsequent Strombolian- and Hawaiian-type activity built a spatter rampart and cone along a line about 650 m long and extruded voluminous pahoehoe and aa flows to the northeast and southeast. Collapse of the vent area near the end of the eruption created a large pit crater; picritic basalt flows from an earlier
R05552	Pahoehoe and aa flow from Nawahine (v4R00555), in the northwest part of the map. Consists of alkali olivine basalt with 1-2 percent olivine phenocrysts.
Q98555	Pahoehoe and aa flow from Nawahine (v4R00555), in the northwest part of the map. Consists of alkali olivine basalt with 4-8 percent olivine, 1-2 percent plagioclase, and less than 1 percent pyroxene phenocrysts.
R00555	Spatter and cinder deposits at Nawahine (northwest part of the map). Consist
Q83533	Spatter cone of Poikahi, in the west-central part of the map. Consists of alkali olivine basalt of two lithologic types: the younger has less than 1 percent olivine phenocrysts, and the older contains 2-4 percent olivine, 1-3 percent plagioclase, and less than 1 percent pyroxene phenocrysts and scattered xenoliths of dunite and gabbro.
Q81553	Spatter cone of Umiahu (west-central part of map), and a pahoehoe and aa flow. A small unmapped spatter cone and associated flow, representing the last stages of the eruption, cover the floor of the main crater of Umiahu. Red and brown
Q90555	Spatter cone and an aa and pahoehoe flow in the west-central part of the map (500 m south-southeast of Kipahee). Consist of alkali olivine basalt with 1-3 percent plagioclase phenocrysts.
Q87541	Cone and a pahoehoe and aa flow in the west-central part of the map. Cone consists almost entirely of flows with very minor spatter. Consist of picritic alkali olivine basalt with 15-20 percent olivine phenocrysts.
Q89536	Spatter cone and a pahoehoe and aa flow in the west-central part of the map.
R25513	Pahoehoe flow

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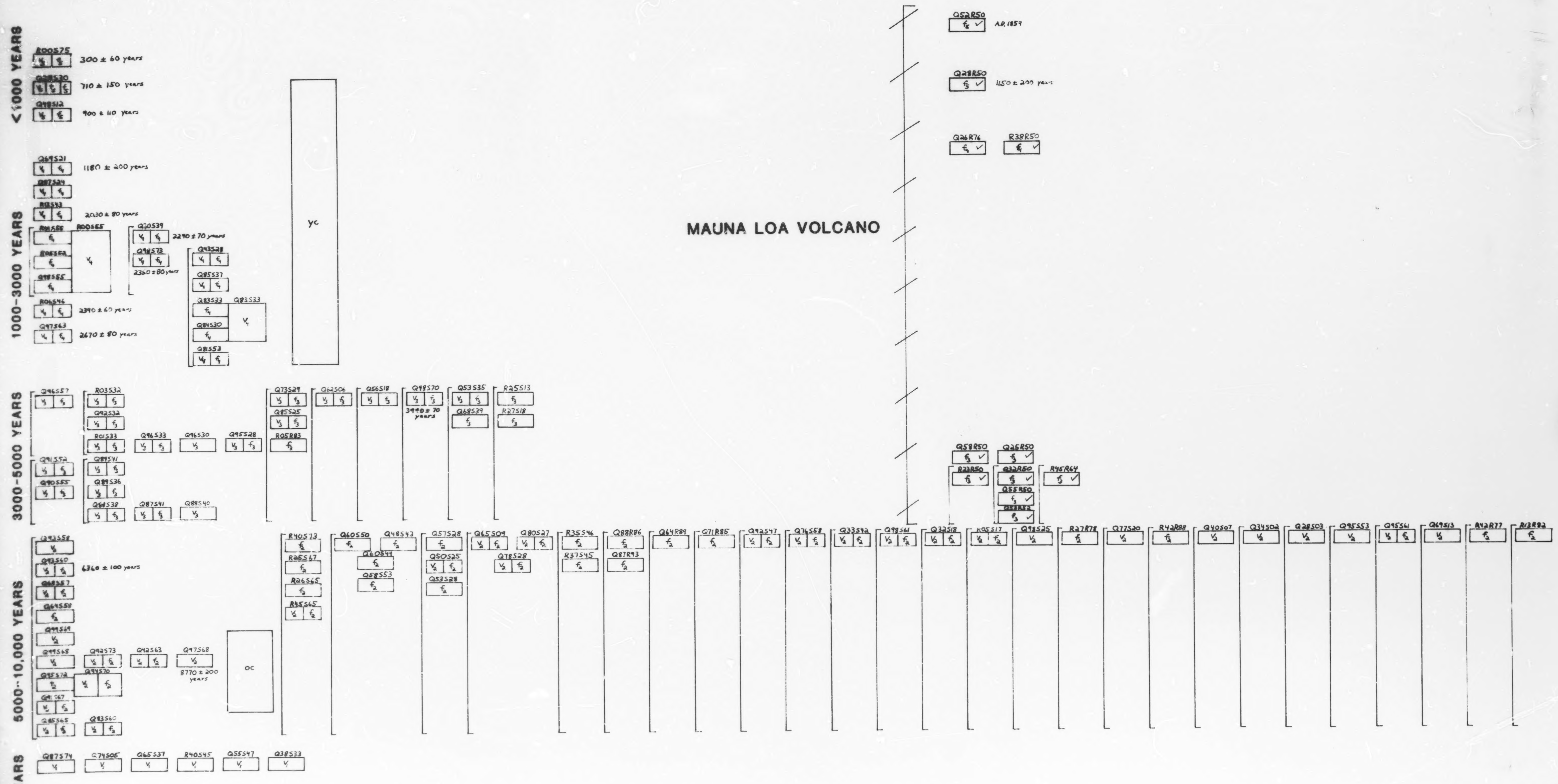
CORRELATION OF MAP UNITS

HUALALAI VOLCANO
VENT DEPOSITS AND LAVA FLOWS



Trachytes occur as xenoliths in three basaltic cinder deposits; they generally are aphyric in hand specimen, but microscopy indicates that nepheline and sodalite microphenocrysts are present in some samples.

UNITS 1,000-3,000 YEARS OLD

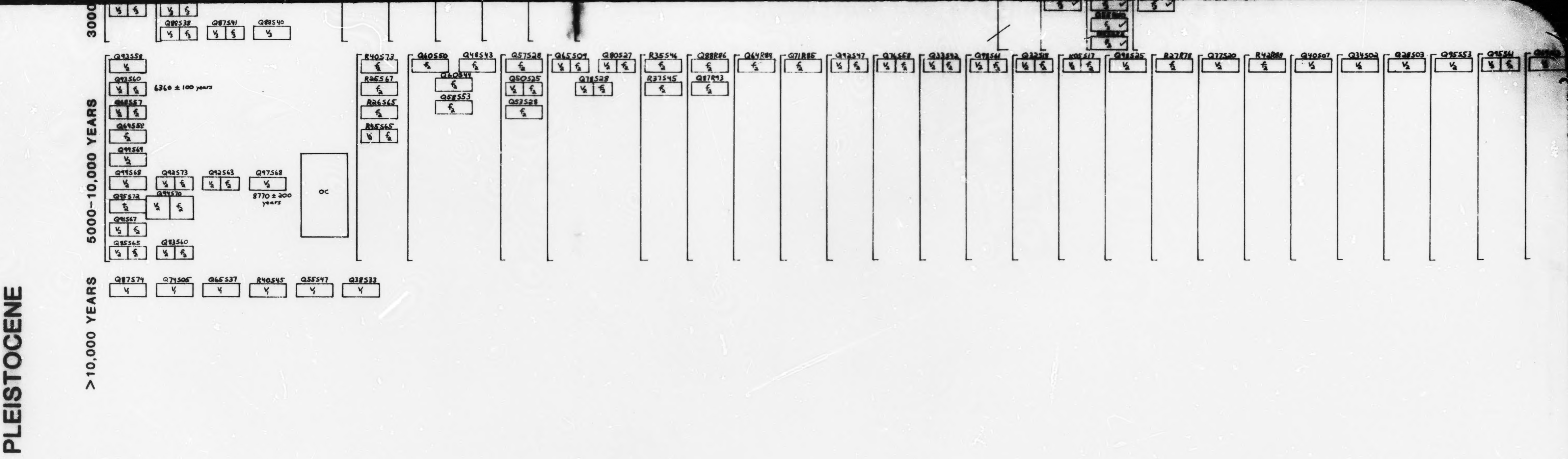
Q69S21 Spatter deposits and pahoehoe and aa flows in the south-central part of the

R05S52 Pahoehoe and aa flow from Nawahine (v4R05S55), in the northwest part of the map. Consists of alkali olivine basalt with 1-2 percent olivine phenocrysts.

Q83S33 Spatter cone of Poikahi, in the west-central part of the map. Consists of alkali olivine basalt of two lithologic types: the younger has less than 1 percent olivine phenocrysts, and the older contains 2-4 percent olivine, 1-3

Q90S55 Spatter cone and an aa and pahoehoe flow in the west-central part of the map (500 m south-southeast of Kipahee). Consist of alkali olivine basalt with 1-3 percent plagioclase phenocrysts.

R25S13 Pahoehoe flow near the north-central edge of the map. Consists of alkali olivine basalt with 1-2 percent olivine and less than 1 percent plagioclase phenocrysts.



GEOLOGIC SUMMARY

The Hualalai quadrangle includes the summit of Hualalai Volcano, most of its major south-southeast-trending rift zone, and most of its diffuse north-trending rift zone. The rift zones are marked by steep-sided spatter and cinder cones and a few satellitic shields; open cracks and normal faults, prominent on Kilauea and Mauna Loa Volcanoes, are virtually absent. Eleven tholeiitic basalt flows from Mauna Loa Volcano cover the eastern ten percent of the quadrangle, where they are interbedded with alkali olivine basalt flows of Hualalai. Most of the area is relatively arid, receiving less than 80 cm of rain per year, although fog is common.

Basaltic lavas of Hualalai in this quadrangle range in age from latest Pleistocene to 300 years old. The oldest lavas form seven small cones that cover less than one percent of the area. They could be earliest Holocene, but extensive weathering and soil development (>0.3 m), the virtual absence of surficial glass, and a ^{14}C age of 8,770 ± 200 years on an overlying cone suggest that most of these cones are Pleistocene.

Lavas that are 5,000-10,000 years old cover about 10 percent of the quadrangle. Their assignment to this age classification is based on absence of delicate primary flow structures, extensive weathering, development of soil 0.3 m thick or less, stratigraphic relations, and a few ^{14}C ages. Most of the large cones in the summit area are of this age, as are several extensive flows in the southwest part of the map and a few isolated cones and flows scattered along the rift zones.

Lavas that are 3,000-5,000 years old cover about 30 percent of the quadrangle. Cones and flows are generally weathered brown with little or no soil cover, except in the rain forest. Primary spatter and flow structures generally are present, as is local surficial glass. Stratigraphic relations and a few ^{14}C ages are further aids in assignment of volcanic units to this age classification.

Lavas that are 1,000-3,000 years old cover about 40 percent of the quadrangle. Stratigraphic relations and several ^{14}C ages document that Hualalai was remarkably active during this period, with at least ten large (>200 x 10^6 m^3) eruptions from different vents scattered across the volcano. Lavas of this age generally are black or dark grey, lack soil, except in the rain forest, and commonly have surficial glass and delicate primary flow and spatter structures.

Three large eruptions have occurred during the last 1,000 years; their lavas cover about 10 percent of the quadrangle. Like the 1,000-3,000-year-old lavas, these are black or dark grey, lack soil, and have surficial glass and delicate primary spatter and flow structures. They are distinguished from the older lavas by stratigraphic relationships and ^{14}C ages. The youngest activity demonstrates that Hualalai is only a dormant volcano and can be expected to erupt again, perhaps within the next few decades (Moore and others, in press).

Deposits of basaltic cinders cover much of the quadrangle, although they are mapped only where underlying units cannot be recognized. Eight sources of young cinders, defined by their fresh glass and black, brown, or red color, have been recognized. Older, palagonitized, yellow-brown cinders cover much of the summit area and probably came from several of the vents that are clustered there. Thin alluvial and colluvial deposits are present but have not been mapped.

Alkali olivine basalts of the Hualalai quadrangle contain variable amounts (estimated in the field) of olivine, plagioclase, and pyroxene phenocrysts; a few basalts are aphyric. MgO contents range from about 4-16 percent; the lowest values occur in basalts that are transitional to hawaiite, and the highest values occur in lavas that contain abundant olivine and pyroxene phenocrysts and approach ankaramite in composition. The latter commonly have abundant xenoliths of dunite, pyroxenite, and gabbro, although similar xenoliths also occur in less porphyritic lavas.

Trachytes occur as xenoliths in three basaltic cinder deposits; they generally are aphyric in hand specimen, but microscopy indicates that nepheline and sodalite microphenocrysts are present in some samples.

DESCRIPTION OF MAP UNITS

HUALALAI VOLCANO

UNITS LESS THAN 1,000 YEARS OLD

R00S75 v_5 f_5 Vent deposits, consisting of spatter that forms ramparts and cones, and a pahoehoe flow (flow is partly aa in the adjoining Kailua quadrangle); source is Luamakami, near the west-central edge of the map. Consists of alkali olivine basalt with 2-5 percent olivine phenocrysts. ^{14}C age is 300 ± 60 years (M. Rubin, written commun., 1979).

Q28S30 v_5 f_5 t_5 Spatter deposits, lava flows, and trachyte-bearing tuff at Waha Pele (south-central edge of map). Early effusive activity built a low spatter cone about 700 m in diameter and extruded short pahoehoe and aa flows. Collapse of the central part of the cone occurred and violent phreatic explosions ejected fragments of country rock, up to 0.5 m in diameter, including trachyte, picritic tholeiitic basalt, and plagioclase-phyric alkali olivine basalt over an area of at least 10 km^2. Maximum exposed thickness of the resulting light grey to white, weakly-consolidated tuff is about 3 m, but it could be thicker. Extrusion of lava identical in chemical composition to the earlier phase resumed, built a 400-m-diameter cone nested within the earlier cone, and produced a large aa flow that reached the coast about 16 km away. Volume of the erupted basalt is estimated at 400 x 10^6 m^3. Spatter cones and flows consist of alkali olivine basalt with 2-4 percent olivine and less than 1 percent plagioclase phenocrysts and locally common xenoliths of dunite, pyroxenite, and gabbro. ^{14}C age of the large youngest flow is 710 ± 150 years (M. Rubin, written commun., 1984); all the eruptive activity probably occurred within a few months or years.

Q48S12 v_5 f_5 Spatter deposits, in the south-central part of the map, and lava flows. Early effusive activity built a low spatter cone about 1 km in diameter and extruded short flows; high fountaining distributed basaltic cinders and scattered small (up to 5 cm) xenoliths of trachyte over an area of several km^2. Continued lava extrusion constructed a satellitic shield within the cone, and voluminous pahoehoe flows rafted away much of the earlier spatter deposits. Flows changed to aa on steeper slopes and moved as far as 12 km from the vent. Collapse of the summit of the shield formed nested pit craters about 150 and 40 m in diameter; a small eruption of spatter and a flow then partly filled the smaller pit crater. Volume of this map unit is estimated at about 800 x 10^6 m^3, one of the largest basaltic eruptions in Hawaii. The early spatter, early flows, and voluminous pahoehoe and aa flows consist of alkali olivine basalt with 1-3 percent olivine phenocrysts. The late spatter and flow that partly filled the pit crater consist of alkali olivine basalt with 4-8 percent olivine and 4-8 percent plagioclase phenocrysts. ^{14}C age of the large aa flow that extends to the north is 900 ± 110 years (M. Rubin, written commun., 1984); all the eruptive activity probably occurred within a few years.

UNITS 1,000-3,000 YEARS OLD

Q69S21 v_4 f_4 Spatter deposits and pahoehoe and aa flows in the south-central part of the map. Initial high fountaining distributed basaltic cinders and abundant small (up to 5 cm) xenoliths of trachyte over a large area (perhaps in excess of 50 km^2), indicating that the eruption was sub-Plinian). Subsequent Strombolian- and Hawaiian-type activity built a spatter rampart and cone along a line about 650 m long and extruded voluminous pahoehoe and aa flows to the northeast and southeast. Collapse of the vent area near the end of the eruption created a large pit crater; picritic basalt flows from an earlier eruption (f_2Q78S28) crop out on the lower walls of this crater. Volume of the erupted products is estimated to exceed 400 x 10^6 m^3. Cinders, spatter, and flows consist of alkali olivine basalt with 1-2 percent olivine phenocrysts. ^{14}C age of the long flow that extends to the north is 1,180 ± 200 years (M. Rubin, written commun., 1984).

Q87S24 v_4 f_4 Spatter deposits near the center of the map and a large aa and pahoehoe flow. Initial eruptive activity built a line of small spatter cones about 1 km long. The eruption became concentrated toward the center of this line, where a large spatter cone was constructed and a voluminous flow was extruded, mainly to the north. Volume of the eruptive products is estimated to be about 400 x 10^6 m^3. Consist of alkali olivine basalt with 2-4 percent olivine and less than 1 percent plagioclase phenocrysts in a locally feldspathic groundmass. Flow overlies f_4R13S43, a 2,030 ± 80-year-old flow, and is overlain by cinders from v_4Q69S21.

R13S43 v_4 f_4 Spatter deposits and aa and pahoehoe flows in the northwest part of the map. Left-stepping *en echelon* eruptive vents occur over a distance of 8 km and cut obliquely across the general strike of the diffuse north-trending rift zone, changing from N10°W at the northern end (in the Puu Anahulu quadrangle) to N50°E at the southwestern end (Kileo and the next vent to the northeast). Lava first erupted at the lower elevation (1128 m; 3700 feet) and gradually broke out higher (maximum elevation 1830 m--6000 feet) on the volcano's north flank as the eruption progressed. Prolonged eruption built spatter cones at Hainoa and Kalamalu (north edge of map) and at Kileo; relatively low spatter ramparts were built at the other vents. Volume of the eruption is estimated to be 400 x 10^6 m^3. Consist of alkali olivine basalt with 2-5 percent olivine, 1-2 percent plagioclase, and less than 1 percent pyroxene phenocrysts in a locally feldspathic groundmass. ^{14}C age of the northern flow is 2,030 ± 80 years (M. Rubin, written commun., 1978); probably all of the lava was extruded over a period of a few months.

R01S58 f_4 Aa flow from Nawahine (v_4R00S55), in the northwest part of the map. Consists of alkali olivine basalt with 6-10 percent plagioclase, 1-2 percent pyroxene, and 1-2 percent olivine phenocrysts.

R05S52 f_4 Pahoehoe and aa flow from Nawahine (v_4R00S55), in the northwest part of the map. Consists of alkali olivine basalt with 1-2 percent olivine phenocrysts.

Q98S56 f_4 Pahoehoe and aa flow from Nawahine (v_4R00S55), in the northwest part of the map. Consists of alkali olivine basalt with 4-8 percent olivine, 1-2 percent plagioclase, and less than 1 percent pyroxene phenocrysts.

R00S55 v_4 Spatter and cinder deposits at Nawahine (northwest part of the map). Consist of alkali olivine basalt of three different lithologies, represented by flows f_4R01S58, f_4R05S52, and f_4Q98S56. One small pit crater within this vent deposit exposes an older unmapped biotite-bearing hawaiite flow. Eruptions at Nawahine occurred between 2,380 ± 60 and 2,030 ± 80 years B.P. (^{14}C ages from M. Rubin, written commun., 1978-1982).

Q30S39 v_4 f_4 Spatter cone of Puu o Kalaukani (near south edge of map), and a pahoehoe and aa flow. Unit is thickly mantled by trachyte-bearing tuff and basaltic cinders from Waha Pele, 900 m to the east. Consist of alkali olivine basalt with 3-6 percent olivine phenocrysts. ^{14}C age is 2,290 ± 70 years (M. Rubin, written commun., 1979).

Q98S73 v_4 f_4 Spatter deposits at Luamakami (near west-central edge of map), and pahoehoe and aa flows. Consist of alkali olivine basalt with 1-3 percent olivine phenocrysts. ^{14}C age is 2,350 ± 80 years (M. Rubin, written commun., 1982).

R06S46 v_4 f_4 Spatter cone and an aa flow in the northwest part of the map. Consist of alkali olivine basalt with 1-2 percent olivine and 1-2 percent plagioclase phenocrysts. ^{14}C age is 2,380 ± 60 years (M. Rubin, written commun., 1982).

Q97S63 v_4 f_4 Cinder and spatter cone and an aa flow in the northwest part of the map. Consist of alkali olivine basalt with 2-4 percent plagioclase and 1-2 percent olivine phenocrysts. ^{14}C age is 2,670 ± 60 years (M. Rubin, written commun., 1982).

Q43S28 v_4 f_4 Spatter cones of Puu o Mawae (south-central part of map), and an aa and pahoehoe flow. Flow is thickly mantled by cinders from Puu o Mawae, Waha Pele, and v_5Q48S12. Consist of alkali olivine basalt with 1-3 percent olivine phenocrysts.

Q85S37 v_4 f_4 Spatter deposits and pahoehoe flows in the west-central part of the map, on the northwest side of Poikahi. Vent deposit is mainly a satellitic shield composed of flows; scattered remnants of spatter are preserved near the rim of a pit crater that formed in the late stages of the eruption. One thin narrow flow extends 4 km to the north; another extends more than 7 km to the south. Consist of alkali olivine basalt with 3-6 percent plagioclase and 3-6 percent olivine phenocrysts in a feldspathic groundmass.

Q83S33 f_4 Pahoehoe flow from Poikahi, in the west-central part of the map. Flow has a prominent lava channel. Consists of alkali olivine basalt with less than 1 percent olivine phenocrysts.

Q84S30 f_4 Aa flow from Poikahi, in the west-central part of the map. Flow is thickly mantled by cinders, mostly from v_4Q69S21 and v_4Q87S24. Consists of alkali olivine basalt with 2-4 percent olivine, 1-3 percent plagioclase, and less than 1 percent pyroxene phenocrysts and scattered xenoliths of dunite and gabbro.

Q83S23 f_4 Spatter cone of Poikahi, in the west-central part of the map. Consists of alkali olivine basalt of two lithologic types: the younger has less than 1 percent olivine phenocrysts, and the older contains 2-4 percent olivine, 1-3 percent plagioclase, and less than 1 percent pyroxene phenocrysts and scattered xenoliths of dunite and gabbro.

Q81S53 v_4 f_4 Spatter cone of Umiahu (west-central part of map), and a pahoehoe and aa flow. A small unmapped spatter cone and associated flow, representing the last stages of the eruption, cover the floor of the main crater of Umiahu. Red and brown cinders from Umiahu mantle nearby units. Consist of alkali olivine basalt with 6-12 percent olivine and less than 1 percent plagioclase phenocrysts.

yc Widespread airfall cinders of alkali olivine basalt, representing the products of vigorous Strombolian and sub-Plinian eruptions. Cinder deposits range up to several meters thick and are black, brown, or red. Identified sources are Waha Pele (v_5Q28S30), v_5Q48S12, v_4Q69S21, Nawahine (v_4R00S55), v_4Q97S63, Puu o Mawae (v_4Q43S28), and Umiahu (v_4Q81S53). Not mapped where underlying units can be recognized.

UNITS 3,000-5,000 YEARS OLD

Q96S57 v_3 f_3 Spatter cone of Kipahee (west-central part of map), and an aa and pahoehoe flow. Consist of alkali olivine basalt with 3-6 percent plagioclase and 3-6 percent olivine phenocrysts.

R03S32 v_3 f_3 Spatter cone and an aa and pahoehoe flow in the northwest part of the map. Consist of alkali olivine basalt with 4-8 percent olivine and 1-2 percent plagioclase phenocrysts.

Q92S32 v_3 f_3 Spatter cone and a pahoehoe and aa flow in the west-central part of the map. Consist of alkali olivine basalt with 1-3 percent plagioclase and less than 1 percent olivine phenocrysts.

R01S33 v_3 f_3 Small spatter cone and a pahoehoe and aa flow in the northwest part of the map. Consist of alkali olivine basalt with 1-3 percent plagioclase and 1-2 percent olivine phenocrysts.

Q96S33 v_3 f_3 Spatter cone and an aa and pahoehoe flow in the west-central part of the map. Consist of alkali olivine basalt with 1-3 percent plagioclase and less than 1 percent olivine phenocrysts.

Q96S30 v_3 Spatter deposits in the west-central part of the map. High-standing spatter is surrounded by f_3Q92S32. Adjacent pit crater may have formed initially during the eruption of v_3Q96S30, but it also transects f_3Q92S32. Consist of alkali olivine basalt with 4-8 percent olivine phenocrysts.

Q95S28 v_3 f_3 Spatter cone and aa and pahoehoe flows in the west-central part of the map. Consist of alkali olivine basalt with 1-3 percent olivine and less than 1 percent plagioclase phenocrysts.

Q91S52 v_3 f_3 Two small spatter and cinder cones in the west-central part of the map (500 m southeast of Kipahee), and an aa and pahoehoe flow. Consist of alkali olivine basalt with 4-8 percent plagioclase and less than 1 percent olivine phenocrysts.

Q90S55 v_3 f_3 Spatter cone and an aa and pahoehoe flow in the west-central part of the map (500 m south-southeast of Kipahee). Consist of alkali olivine basalt with 1-3 percent plagioclase phenocrysts.

Q89S41 v_3 f_3 Cone and a pahoehoe and aa flow in the west-central part of the map. Cone consists almost entirely of flows with very minor spatter. Consist of picritic alkali olivine basalt with 15-20 percent olivine phenocrysts.

Q89S36 v_3 f_3 Spatter cone and a pahoehoe and aa flow in the west-central part of the map. Consist of alkali olivine basalt with 6-10 percent olivine phenocrysts

Q88S38 v_3 f_3 Spatter deposits and an aa and pahoehoe flow in the west-central part of the map. Consist of alkali olivine basalt with 2-4 percent olivine phenocrysts.

Q87S41 v_3 f_3 Spatter ramparts and pahoehoe flows in the west-central part of the map. Consist of alkali olivine basalt with 3-6 percent plagioclase phenocrysts.

Q88S40 v_3 Two small spatter cones in the west-central part of the map. Consist of alkali olivine basalt with 2-6 percent olivine phenocrysts.

Q73S29 v_3 f_3 Spatter deposits of Kauunuoku (southwest part of map) and five adjacent vents, and pahoehoe and minor aa flows. Consist of alkali olivine basalt with 3-8 percent olivine phenocrysts.

Q85S25 v_3 f_3 Spatter deposits that form four cones (three of which are Mailehahei, Puu Maau, and Kealoha) near the center of the map, and a large aa and pahoehoe flow. Consist of alkali olivine basalt with 10-20 percent olivine, 2-10 percent plagioclase, and 2-10 percent pyroxene phenocrysts and locally common xenoliths of gabbro.

R05R83 f_3 Aa flow in the northeast part of the map. Consists of alkali olivine basalt with 1-3 percent olivine phenocrysts in a locally feldspathic groundmass.

Q62S06 v_3 f_3 Spatter cone and a pahoehoe flow, with eight lava channels radiating from the cone, in the southeast part of the map. Consist of alkali olivine basalt with 1-2 percent olivine and less than 1 percent plagioclase phenocrysts.

Q56S18 v_3 f_3 Satellitic shield of Pohakuloa (south-central part of map), an associated small spatter deposit (v_3; shield is included in f_3), and pahoehoe and aa flows. Consist of alkali olivine basalt with 10-15 percent olivine phenocrysts

Q98S70 v_3 f_3 Low, left-stepping *en echelon* spatter ramparts and short pahoehoe and aa flows near the west-central edge of the map; includes a small explosion crater that transects the north flank of Puu Honuaula (v_2Q92S73). Consist of alkali olivine basalt with 2-6 percent olivine, 0-2 percent plagioclase, and less than 1 percent pyroxene phenocrysts. ^{14}C age is 3,990 ± 70 years (M. Rubin, written commun., 1982).

Q53S35 v_3 f_3 Spatter cone of Hinau (southwest part of map) and a pahoehoe flow. Consist of alkali olivine basalt with 4-8 percent olivine and 1-2 percent plagioclase phenocrysts.

Q68S39 f_3 Pahoehoe and aa flow in the southwest part of the map. Consists of alkali olivine basalt with 1-3 percent olivine phenocrysts.

Q95S72 t_2 Tuff on the north rim of Hainoa Crater (near west-central edge of map) and on north wall of pit crater transecting v_2Q97S68. Consists of red to yellow palagonitic tuff, up to 1 m thick, with boulders of the underlying f_2Q94S70 and gabbro and diabase from a subjacent intrusion. Tuff is interpreted as the deposit resulting from explosive phreatic eruptions accompanying the formation of Hainoa Crater near the end of construction of a satellitic shield (f_2Q94S70). At Hainoa Crater, tuff is overlain by a single hybrid flow consisting of mixed hawaiite with less than 1 percent plagioclase phenocrysts and alkali olivine basalt with 5-10 percent plagioclase, 2-5 percent olivine, and less than 1 percent pyroxene phenocrysts. Two hundred m north, in cone v_2Q97S68, the tuff is overlain by 6 m of flows of unit f_2Q94S70

Q94S70 v_2 f_2 Spatter deposits and pahoehoe and aa flows in and near Hainoa Crater (near west-central edge of map). The deposits are associated with formation of a satellitic shield near the summit of Hualalai Volcano. Shield-building flows of this map unit also crop out in the bottoms of pit craters at cones v_2Q97S68, v_2Q99S69, and v_4R00S55 (Nawahine). Consist of alkali olivine basalt, transitional to hawaiite, with 8-12 percent plagioclase, 2-4 percent olivine, and 1-2 percent pyroxene phenocrysts; xenoliths of dunite, pyroxenite, and gabbro occur in two of the pyroclastic deposits.

Q91S67 v_2 f_2 Spatter cone of Puu Lalakaukole (near west-central edge of map; forms summit of Hualalai Volcano) and aa and pahoehoe flows. Consist of alkali olivine basalt with 5-10 percent olivine, 5-10 percent plagioclase, and less than 1 percent pyroxene phenocrysts; scattered xenoliths of gabbro and anorthosite are present.

oc Widespread airfall cinders of alkali olivine basalt, representing the products of vigorous Strombolian or sub-Plinian eruptions. Cinder deposits are up to several meters thick and are yellow-brown. Sources include Hainoa Crater and possibly other nearby vents. Not mapped where underlying units can be recognized.

Q85S65 v_2 f_2 Spatter cone and an aa and pahoehoe flow in the west-central part of the map. Consist of alkali olivine basalt with 5-10 percent plagioclase, 2-4 percent olivine, and less than 1 percent pyroxene phenocrysts.

Q83S60 v_2 f_2 Spatter deposits (including Kumukou) and short aa and pahoehoe flows in the west-central part of the map. Kumukou and another small cone are composed of pahoehoe with almost no spatter. Consist of alkali olivine basalt with 3-8 percent plagioclase and 1-3 percent olivine phenocrysts.

R40S73 f_2 Aa and pahoehoe flow in the northwest corner of the map. Consists of alkali olivine basalt with 4-8 percent olivine phenocrysts.

R25S67 f_2 Aa and pahoehoe flow in the northwest corner of the map. Consists of alkali olivine basalt with 3-6 percent plagioclase and 1-2 percent olivine phenocrysts.

R26S65 f_2 Aa and pahoehoe flow in the northwest part of the map. Consists of alkali olivine basalt with 8-12 percent olivine phenocrysts.

R45S65 v_2 f_2 Spatter and cinder cone of Poohohoo (northwest corner of map) and a pahoehoe flow. Consist of alkali olivine basalt with 10-15 percent olivine phenocrysts.

Q60S50 f_2 Aa flow in the southwest part of the map. Consists of alkali olivine basalt with 1-3 percent plagioclase and less than 1 percent each of olivine and pyroxene phenocrysts.

Q48S43 f_2 Aa and pahoehoe flow in the southwest part of the map. Consists of alkali olivine basalt with 2-4 percent olivine, 1-2 percent plagioclase, and less than 1 percent pyroxene phenocrysts.

Q60S44 f_2 Aa flow in the southwest part of the map. Consists of alkali olivine basalt with 1-3 percent plagioclase and less than 1 percent each of olivine and pyroxene phenocrysts.

Q58S53 f_2 Aa and pahoehoe flow in the southwest part of the map. Consists of alkali olivine basalt with 1-3 percent olivine and 1-3 percent plagioclase phenocrysts.

Q57S28 f_2 Aa flow in the south-central part of the map. Consists of alkali olivine basalt with 2-4 percent olivine and 1-2 percent plagioclase phenocrysts.

Q50S35 v_2 f_2 Three spatter cones and associated aa flows in the south-central part of the map. Consist of alkali olivine basalt, transitional to hawaiite, with 5-10 percent plagioclase and 1-2 percent olivine phenocrysts.

Q53S28 f_2 Small aa flow in the south-central part of the map. Consists of alkali olivine basalt with 10-15 percent olivine phenocrysts.

Q65S09 v_2 f_2 Satellitic shield, consisting of pahoehoe flows, one unmapped dike, and associated spatter deposits, in the south-central part of the map. A deep (>120 m) pit crater formed near the end of the eruption; a small late-stage vent is visible near the bottom of the crater. Lava flows on the lower walls of the pit crater are inaccessible but appear similar to f_2Q78S28 in the large crater (v_4Q69S21) 1.3 km to the west-northwest. Consist of alkali olivine basalt with 1-2 percent olivine and less than 1 percent plagioclase phenocrysts.

Q80S27 v_2 f_2 Spatter rampart and a small pahoehoe flow near the center of the map. Consist of alkali olivine basalt with 4-8 percent olivine and 1-3 percent plagioclase phenocrysts.

Q78S28 v_2 f_2 Pahoehoe flows, with minor spatter deposits and aa, near the center of the map. Cones built at the two vents consist almost entirely of pahoehoe. Similar-appearing flows occur on the lower walls of two craters 1.3 and 2.5 km southeast of the vents. Consist of picritic alkali olivine basalt with 15-25 percent olivine phenocrysts.

R35S46 f_2 Aa flow at Shangri-la (northwest part of map). Consists of alkali olivine basalt with 8-12 percent olivine phenocrysts in a locally feldspathic groundmass.

R37S45 f_2 Aa flow on the east side of Potato Hill (northwest part of map). Consists of alkali olivine basalt with 6-10 percent plagioclase, 2-4 percent olivine, and less than 1 percent pyroxene phenocrysts and scattered xenoliths of gabbro.

Q88R86 f_2 Aa and pahoehoe flow in the east-central part of the map. Consists of alkali olivine basalt with 3-5 percent olivine phenocrysts.

Q87R93 f_2 Pahoehoe flow in the east-central part of the map. Consists of alkali olivine basalt with 5-10 percent olivine phenocrysts in a feldspathic groundmass.

Q64R89 f_2 Aa and pahoehoe flow in the east-central part of the map. Consists of alkali olivine basalt with 2-4 percent olivine and 1-3 percent plagioclase phenocrysts.

Q71R85 f_2 Aa flow in the east-central part of the map. Consists of alkali olivine basalt with 3-6 percent plagioclase, 1-3 percent olivine, and less than 1 percent pyroxene phenocrysts.

Q92S47 v_2 f_2 Spatter cone and an aa and pahoehoe flow in the west-central part of the map. Consist of alkali olivine basalt with 15-20 percent olivine, 1-2 percent pyroxene, and less than 1 percent plagioclase phenocrysts and common xenoliths of gabbro, pyroxenite, and dunite.

Q76S58 v_2 f_2 Spatter cone of Puu Nenoakolu (southwest part of map) and an aa and pahoehoe flow. Consist of alkali olivine basalt with 3-6 percent olivine phenocrysts.

Q33S42 v_2 f_2 Spatter cone of Pihapono (southwest part of map) and a pahoehoe flow. Consist of alkali olivine basalt with 6-12 percent olivine and less than 1 percent plagioclase phenocrysts.

Q98S61 v_2 f_2 Spatter cone and a small pahoehoe flow, confined within the cone, near the west-central edge of the map. Consist of picritic alkali olivine basalt with 15-20 percent olivine and less than 1 percent each of pyroxene and plagioclase phenocrysts; scattered xenoliths of gabbro are present.

Q32S18 v_2 f_2 Spatter cone of Puu Ikaaka (near south-central edge of map) and an aa and pahoehoe flow; flow is thickly mantled by cinders and spatter rafted from the vent. Consist of alkali olivine basalt, transitional to ankaramite, with 15-20 percent olivine, 5-10 percent pyroxene, and less than 1 percent plagioclase phenocrysts. Xenoliths of dunite and minor pyroxenite and gabbro are abundant.

R05S17 v_2 f_2 Spatter cone of Puu Nahaha (north-central part of map) and a pahoehoe and aa flow. Consist of alkali olivine basalt with 5-10 percent olivine phenocrysts.

Q98S26 v_2 Small spatter cone near the center of the map. Consists of alkali olivine basalt with 3-6 percent olivine phenocrysts.

R27R78 f_2 Pahoehoe flow in the northeast part of the map. Consists of alkali olivine basalt with 10-15 percent olivine phenocrysts.

Q77S30 v_2 Small spatter cone near the center of the map. Consists of alkali olivine basalt with 3-6 percent olivine phenocrysts.

R42R88 f_2 Aa flow in the northeast part of the map. Consists of alkali olivine basalt with 1-2 percent olivine and less than 1 percent plagioclase phenocrysts.

Q40S07 v_2 Small spatter cone in the south-central part of the map. Consists of alkali olivine basalt with 2-4 percent plagioclase and less than 1 percent olivine phenocrysts.

Q34S02 v_2 Spatter cone in the southeast part of the map. Consists of alkali olivine basalt with 3-6 percent plagioclase and 1-3 percent olivine phenocrysts.

Q28S03 v_2 Spatter cone near the south edge of the map. Consists of alkali olivine basalt with 4-8 percent plagioclase and less than 1 percent olivine phenocrysts.

Q95S53 v_2 Small cinder and spatter cone 200 m east of Kipahee, in the west-central part of the map. Consists of alkali olivine basalt with 2-4 percent olivine, 1-3 percent plagioclase, and less than 1 percent pyroxene phenocrysts.

Q95S61 v_2 f_2 Small spatter rampart and an aa flow in the west-central part of the map. Consists of alkali olivine basalt with 3-6 percent plagioclase and 1-2 percent olivine phenocrysts.

Q69S13 v_2 Spatter cone in the south-central part of the map. Consists of picritic alkali olivine basalt with 15-20 percent olivine and 1-2 percent pyroxene phenocrysts.

R42R77 f_2 Small pahoehoe flow in the northeast part of the map. Consists of alkali olivine basalt with 5-10 percent olivine and 1-3 percent plagioclase phenocrysts.

R13R82 f_2 Small aa flow in the northeast part of the map. Consists of alkali olivine basalt with 8-15 percent olivine, 3-6 percent plagioclase, and 1-3 percent pyroxene phenocrysts and scattered xenoliths of gabbro.

UNITS MORE THAN 10,000 YEARS OLD

Q87S74 v_1 Spatter cone near the west-central edge of the map. Consists of alkali olivine basalt with 5-10 percent olivine, 3-6 percent pyroxene, and 1-3 percent plagioclase phenocrysts.

Q74S05 v_1 Spatter cone near the center of the map. Consists of alkali olivine basalt with 2-5 percent olivine phenocrysts.

Q65S37 v_1 Small spatter and cinder cone in the southwest part of the map. Consists of alkali olivine basalt with 3-6 percent plagioclase and 1-2 percent olivine phenocrysts.

R40S45 v_1 Cinder and spatter cone of Potato Hill (northwest part of map). Consists of alkali olivine basalt with 2-4 percent olivine phenocrysts.

Q55S47 v_1 Spatter cone in the southwest part of the map. Consists of alkali olivine basalt with 2-4 percent olivine phenocrysts.

Q38S33 v_1 Two small spatter cones in the southwest part of the map. Consist of alkali olivine basalt with 4-8 percent olivine phenocrysts.

MAUNA LOA VOLCANO

UNITS LESS THAN 1,000 YEARS OLD

Q52R50 f_5 Pahoehoe and aa flows, erupted in A.D. 1859 (Stearns and Macdonald, 1946)(east edge of map). Consist of tholeiitic basalt with 1-3 percent olivine phenocrysts.

Q29R50 f_5 Pahoehoe flow in the southeast part of the map. Consists of tholeiitic basalt with 5-10 percent olivine phenocrysts in a feldspathic groundmass. ^{14}C age is 1,150 ± 200 years (M. Rubin, written commun., 1985); flow overlies a Hualalai flow (f_5Q48S12) dated at 900 ± 110 years, so both flows probably were erupted about 1,000 years ago.

UNITS 1,000-3,000 YEARS OLD

Q26R76 f_4 Pahoehoe flow near the southeast edge of the map. Consists of tholeiitic basalt with 1 percent olivine phenocrysts in a locally feldspathic groundmass. Flow overlies Hualalai flow f_4Q69S21, which is dated at 1,180 ± 200 years.

R38R50 f_4 Aa flow in the northeast corner of the map. Consists of tholeiitic basalt with 1-3 percent olivine phenocrysts and rare xenoliths of troctolite.

UNITS 3,000-5,000 YEARS OLD

Q58R50 f_3 Large pahoehoe flow, locally with very minor aa, in the east and northeast parts of the map. Flow is dense, vesicle-poor, and characterized by a rind of surficial glass 1-6 cm thick. Consists of tholeiitic basalt generally with 2-4 percent olivine phenocrysts in a locally feldspathic groundmass; rarely, the flow contains lenses with as much as 10-15 percent olivine phenocrysts.

Q25R50 f_3 Pahoehoe flow near the southeast corner of the map. Consists of generally picritic tholeiitic basalt with 10-25 percent olivine phenocrysts in a locally feldspathic groundmass.

R23R50 f_3 Pahoehoe and aa flow in the northeast part of the map. Consists of picritic tholeiitic basalt with 15-25 percent olivine and 5-10 percent plagioclase phenocrysts.

Q31R50 f_3 Pahoehoe flow, locally with minor aa, along the east edge of the map. Consists of picritic tholeiitic basalt with 15-25 percent olivine phenocrysts.

Q65R50 f_3 Aa and pahoehoe flow at Halelaau (near southeast edge of map). Flow is deeply weathered and stained reddish-brown. Consists of picritic tholeiitic basalt with 15-25 percent olivine and 5-10 percent plagioclase phenocrysts.

Q63R52 f_3 Pahoehoe flow at Halelaau (near southeast edge of map). Consists of tholeiitic basalt with 3-6 percent olivine phenocrysts in a locally feldspathic groundmass.

R45R64 f_3 Pahoehoe flow in three small kipukas near the northeast corner of the map. Consists of tholeiitic basalt with 4-8 percent olivine and 2-6 percent plagioclase phenocrysts.

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GEOLOGIC MAP SYMB

f=flow, v=vent deposit, t=tuff
Subscript (1-5) indicates relative age classificati
4=1,000-3,000 years old; 3=3,000-5,000 years
1=>10,000 years old

A six-character symbol consisting of a letter plus
letter and two more digits is a unique geographic
and its related flows. The pair of letter-digit-di
pair of coordinates on an island-wide grid based
and C.A. Neal, written commun., 1986). The letters
the grid. In the Hualalai quadrangle, Q or R in th
respectively, to latitude 19°36' and 19°42' or 19.6
in the fourth position correspond, respectively, to
or 155.7° and 155.8°. The two numbers that follow
hundredths and thousandths of degrees. Thus, the
grid position at latitude 19.648° and longitude 155.
that cannot be traced to vents within the Hualalai
to represent the grid position within the quadrangl
to the axis of Hualalai's major south-southeast-tre

Each volcanic map unit is the product of a brief
^{14}C ages (there are only 13 for the Hualalai quadra
about the absolute age of a map unit. The units ar
groups on the bases of field stratigraphic relatio
of soil development, and degree of degradation of
features. A bracket on the correlation chart (exce
diagonal lines distinguishing the Mauna Loa flows)
range of any unit or sequence of units. Stratigrap
by the vertical placement on the correlation chart.

—— Contact, approximately located

X Location and age of ^{14}C-dated charcoal sample

Geology mapped 1980-1985

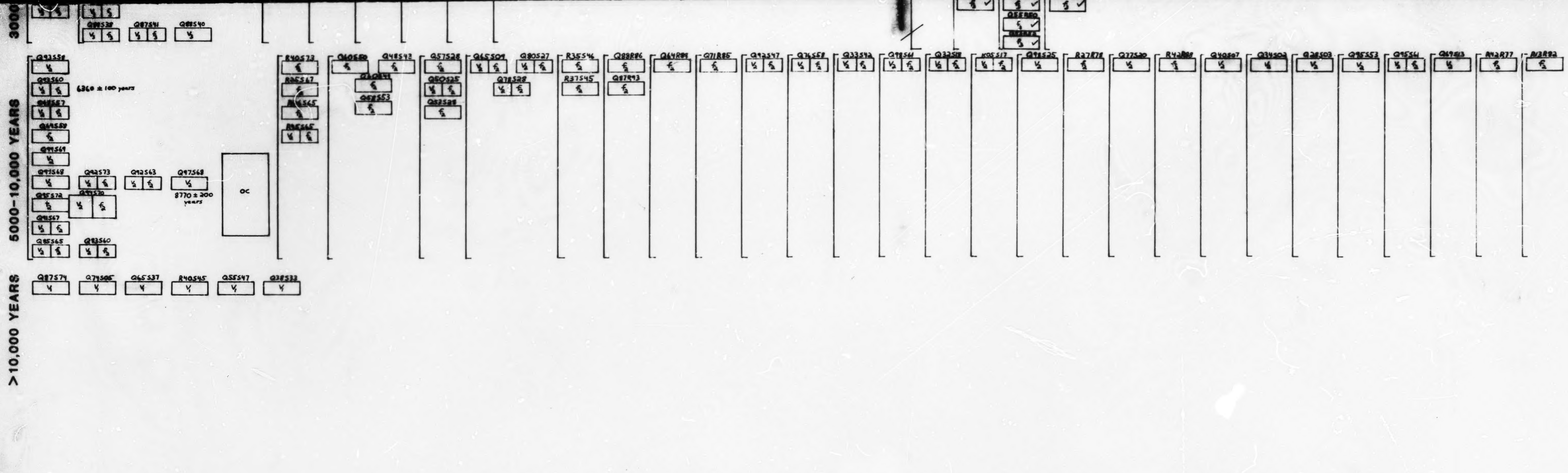
o/y Relatively older and younger units, at locati

✓✓ Pattern on Mauna Loa flows

PRELIMINARY GEOLOGIC MAP OF THE HUALALAI QUADRANGLE, HAWAII

by Richard B. Moore, Frank A. Trusdell, David A. Clague, and Wendy A. Bohrson

1986



f Hualalai Volcano, most of its
of its diffuse north-trending rift
tter and cinder cones and a few
prominent on Kilauea and Mauna Loa
basalt flows from Mauna Loa
ngle, where they are interbedded
of the area is relatively arid,
fog is common.
range in age from latest
seven small cones that cover
rliest Holocene, but extensive
l absence of surficial glass,
cones suggest that most of these

10 percent of the quadrangle.
an absence of delicate primary
d soil 0.3 m thick or less,
f the large cones in the summit
in the southwest part of the
ng the rift zones.
ut 30 percent of the quadrangle.
little or no soil cover, except
tures generally are present,
es and a few 14C ages are further
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st that Hualalai was remarkably
(300 x 10⁶ m³) eruptions from
s of this age generally are black
and commonly have surficial glass

last 1,000 years; their lavas
1,000-3,000-year-old lavas, these
l glass and delicate primary
from the older lavas by
est activity demonstrates that
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quadrangle, although they are
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are clustered there. Thin
not been mapped.
gle contain variable amounts
d pyroxene phenocrysts; a few
4-18 percent; the lowest values
and the highest values occur in
ocrysts and approach ankaramite
enoliths of dunite, pyroxenite,
less porphyritic lavas.

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overlain by a single hybrid
1 percent plagioclase
percent plagioclase, 2-5
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and near Hainoa Crater (near
associated with formation of a
lcano. Shield-building flows
of pit craters at cones v₂Q97S68,
alkali olivine basalt,
ioclase, 2-4 percent olivine,
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s of gabbro and anorthosite

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aa and pahoehoe flows in the
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alkali olivine basalt with
phenocrysts.

f the map. Consists of alkali
rysts.

f the map. Consists of alkali
d 1-2 percent olivine phenocrysts.

the map. Consists of alkali
crysts.

corner of map) and a pahoehoe
0-15 percent olivine phenocrysts.

Trachytes occur as xenoliths in three basaltic cinder deposits; they generally are aphyric in hand specimen, but microscopy indicates that nepheline and sodalite microphenocrysts are present in some samples.

DESCRIPTION OF MAP UNITS

HUALALAI VOLCANO

UNITS LESS THAN 1,000 YEARS OLD

R00S75 v_5 f_5 Vent deposits, consisting of spatter that forms ramparts and cones, and a pahoehoe flow (flow is partly aa in the adjoining Kailua quadrangle); source is Luamakami, near the west-central edge of the map. Consists of alkali olivine basalt with 2-5 percent olivine phenocrysts. 14C age is 300 ± 60 years (M. Rubin, written commun., 1979).

Q28S30 v_5 f_5 t_5 Spatter deposits, lava flows, and trachyte-bearing tuff at Waha Pele (south-central edge of map). Early effusive activity built a low spatter cone about 700 m in diameter and extruded short pahoehoe and aa flows. Collapse of the central part of the cone occurred and violent phreatic explosions ejected fragments of country rock, up to 0.5 m in diameter, including trachyte, picritic tholeiitic basalt, and plagioclase-phyric alkali olivine basalt over an area of at least 10 km². Maximum exposed thickness of the resulting light grey to white, weakly-consolidated tuff is about 3 m, but it could be thicker. Extrusion of lava identical in chemical composition to the earlier phase resumed, built a 400-m-diameter cone nested within the earlier cone, and produced a large aa flow that reached the coast about 16 km away. Volume of the erupted basalt is estimated at 400 x 10⁶ m³. Spatter cones and flows consist of alkali olivine basalt with 2-4 percent olivine and less than 1 percent plagioclase phenocrysts and locally common xenoliths of dunite, pyroxenite, and gabbro. 14C age of the large youngest flow is 710 ± 150 years (M. Rubin, written commun., 1984); all the eruptive activity probably occurred within a few months or years.

Q48S12 v_5 f_5 Spatter deposits, in the south-central part of the map, and lava flows. Early effusive activity built a low spatter cone about 1 km in diameter and extruded short flows; high fountaining distributed basaltic cinders and scattered small (up to 5 cm) xenoliths of trachyte over an area of several km². Continued lava extrusion constructed a satellitic shield within the cone, and voluminous pahoehoe flows rafted away much of the earlier spatter deposits. Flows changed to aa on steeper slopes and moved as far as 12 km from the vent. Collapse of the summit of the shield formed nested pit craters about 150 and 40 m in diameter; a small eruption of spatter and a flow then partly filled the smaller pit crater. Volume of this map unit is estimated at about 600 x 10⁶ m³, one of the largest basaltic eruptions in Hawaii. The early spatter, early flows, and voluminous pahoehoe and aa flows consist of alkali olivine basalt with 1-3 percent olivine phenocrysts. The late spatter and flow that partly filled the pit crater consist of alkali olivine basalt with 4-8 percent olivine and 4-8 percent plagioclase phenocrysts. 14C age of the large aa flow that extends to the north is 900 ± 110 years (M. Rubin, written commun., 1984); all the eruptive activity probably occurred within a few years.

UNITS 1,000-3,000 YEARS OLD

Q69S21 v_4 f_4 Spatter deposits and pahoehoe and aa flows in the south-central part of the map. Initial high fountaining distributed basaltic cinders and abundant small (up to 5 cm) xenoliths of trachyte over a large area (perhaps in excess of 50 km², indicating that the eruption was sub-Plinian). Subsequent Strombolian- and Hawaiian-type activity built a spatter rampart and cone along a line about 650 m long and extruded voluminous pahoehoe and aa flows to the northeast and southeast. Collapse of the vent area near the end of the eruption created a large pit crater; picritic basalt flows from an earlier eruption (f_2Q78S28) crop out on the lower walls of this crater. Volume of the erupted products is estimated to exceed 400 x 10⁶ m³. Cinders, spatter, and flows consist of alkali olivine basalt with 1-2 percent olivine phenocrysts. 14C age of the long flow that extends to the north is 1,180 ± 200 years (M. Rubin, written commun., 1984).

Q87S24 v_4 f_4 Spatter deposits near the center of the map and a large aa and pahoehoe flow. Initial eruptive activity built a line of small spatter cones about 1 km long. The eruption became concentrated toward the center of this line, where a large spatter cone was constructed and a voluminous flow was extruded, mainly to the north. Volume of the eruptive products is estimated to be about 400 x 10⁶ m³. Consist of alkali olivine basalt with 2-4 percent olivine and less than 1 percent plagioclase phenocrysts in a locally feldspathic groundmass. Flow overlies f_4R13S43, a 2,030 ± 80-year-old flow, and is overlain by cinders from v_4Q69S21.

R13S43 v_4 f_4 Spatter deposits and aa and pahoehoe flows in the northwest part of the map. Left-stepping en echelon eruptive vents occur over a distance of 8 km and cut obliquely across the general strike of the diffuse north-trending rift zone, changing from N10°W at the northern end (in the Puu Anahulu quadrangle) to N50°E at the southwestern end (Kileo and the next vent to the northeast). Lava first erupted at the lower elevation (1129 m; 3700 feet) and gradually broke out higher (maximum elevation 1830 m--6000 feet) on the volcano's north flank as the eruption progressed. Prolonged eruption built spatter cones at Hainoa and Kalamalu (north edge of map) and at Kileo; relatively low spatter ramparts were built at the other vents. Volume of the eruption is estimated to be 400 x 10⁶ m³. Consist of alkali olivine basalt with 2-5 percent olivine, 1-2 percent plagioclase, and less than 1 percent pyroxene phenocrysts in a locally feldspathic groundmass. 14C age of the northern flow is 2,030 ± 80 years (M. Rubin, written commun., 1978); probably all of the lava was extruded over a period of a few months.

R01S58 f_4 Aa flow from Nawahine (v_4R00S55), in the northwest part of the map. Consists of alkali olivine basalt with 6-10 percent plagioclase, 1-2 percent pyroxene, and 1-2 percent olivine phenocrysts.

R06S52 f_4 Pahoehoe and aa flow from Nawahine (v_4R00S55), in the northwest part of the map. Consists of alkali olivine basalt with 1-2 percent olivine phenocrysts.

Q98S55 f_4 Pahoehoe and aa flow from Nawahine (v_4R00S55), in the northwest part of the map. Consists of alkali olivine basalt with 4-8 percent olivine, 1-2 percent plagioclase, and less than 1 percent pyroxene phenocrysts.

R00S55 v_4 Spatter and cinder deposits at Nawahine (northwest part of the map). Consist of alkali olivine basalt of three different lithologies, represented by flows f_4R01S58, f_4R06S52, and f_4Q98S55. One small pit crater within this vent deposit exposes an older unmapped biotite-bearing hawaiite flow. Eruptions at Nawahine occurred between 2,390 ± 60 and 2,030 ± 80 years B.P. (14C ages from M. Rubin, written commun., 1978-1982).

Q30S39 v_4 f_4 Spatter cone of Puu o Kalaukani (near south edge of map), and a pahoehoe and aa flow. Unit is thickly mantled by trachyte-bearing tuff and basaltic cinders from Waha Pele, 900 m to the east. Consist of alkali olivine basalt with 3-6 percent olivine phenocrysts. 14C age is 2,290 ± 70 years (M. Rubin, written commun., 1979).

Q98S73 v_4 f_4 Spatter deposits at Luamakami (near west-central edge of map), and pahoehoe and aa flows. Consist of alkali olivine basalt with 1-3 percent olivine phenocrysts. 14C age is 2,350 ± 80 years (M. Rubin, written commun., 1982).

R06S46 v_4 f_4 Spatter cone and an aa flow in the northwest part of the map. Consist of alkali olivine basalt with 1-2 percent olivine and 1-2 percent plagioclase phenocrysts. 14C age is 2,390 ± 60 years (M. Rubin, written commun., 1982).

Q97S63 v_4 f_4 Cinder and spatter cone and an aa flow in the northwest part of the map. Consist of alkali olivine basalt with 2-4 percent plagioclase and 1-2 percent olivine phenocrysts. 14C age is 2,670 ± 80 years (M. Rubin, written commun., 1982).

Q43S28 v_4 f_4 Spatter cones of Puu o Mawae (south-central part of map), and an aa and pahoehoe flow. Flow is thickly mantled by cinders from Puu o Mawae, Waha Pele, and v_5Q48S12. Consist of alkali olivine basalt with 1-3 percent olivine phenocrysts.

Q85S37 v_4 f_4 Spatter deposits and pahoehoe flows in the west-central part of the map, on the northwest side of Poikahi. Vent deposit is mainly a satellitic shield composed of flows; scattered remnants of spatter are preserved near the rim of a pit crater that formed in the late stages of the eruption. One thin narrow flow extends 4 km to the north; another extends more than 7 km to the south. Consist of alkali olivine basalt with 3-6 percent plagioclase and 3-6 percent olivine phenocrysts in a feldspathic groundmass.

Q83S33 f_4 Pahoehoe flow from Poikahi, in the west-central part of the map. Flow has a prominent lava channel. Consists of alkali olivine basalt with less than 1 percent olivine phenocrysts.

Q84S30 f_4 Aa flow from Poikahi, in the west-central part of the map. Flow is thickly mantled by cinders, mostly from v_4Q69S21 and v_4Q87S24. Consists of alkali olivine basalt with 2-4 percent olivine, 1-3 percent plagioclase, and less than 1 percent pyroxene phenocrysts and scattered xenoliths of dunite and gabbro.

Q83S33 f_4 Spatter cone of Poikahi, in the west-central part of the map. Consists of alkali olivine basalt of two lithologic types: the younger has less than 1 percent olivine phenocrysts, and the older contains 2-4 percent olivine, 1-3 percent plagioclase, and less than 1 percent pyroxene phenocrysts and scattered xenoliths of dunite and gabbro.

Q81S53 v_4 f_4 Spatter cone of Umiahu (west-central part of map), and a pahoehoe and aa flow. A small unmapped spatter cone and associated flow, representing the last stages of the eruption, cover the floor of the main crater of Umiahu. Red and brown cinders from Umiahu mantle nearby units. Consist of alkali olivine basalt with 6-12 percent olivine and less than 1 percent plagioclase phenocrysts.

yc Widespread airfall cinders of alkali olivine basalt, representing the products of vigorous Strombolian and sub-Plinian eruptions. Cinder deposits range up to several meters thick and are black, brown, or red. Identified sources are Waha Pele (v_5Q28S30), v_5Q48S12, v_4Q69S21, Nawahine (v_4R00S55), v_4Q97S63, Puu o Mawae (v_4Q43S28), and Umiahu (v_4Q81S53). Not mapped where underlying units can be recognized.

UNITS 3,000-5,000 YEARS OLD

Q96S57 v_3 f_3 Spatter cone of Kipahee (west-central part of map), and an aa and pahoehoe flow. Consist of alkali olivine basalt with 3-6 percent plagioclase and 3-6 percent olivine phenocrysts.

R03S32 v_3 f_3 Spatter cone and an aa and pahoehoe flow in the northwest part of the map. Consist of alkali olivine basalt with 4-8 percent olivine and 1-2 percent plagioclase phenocrysts.

Q92S32 v_3 f_3 Spatter cone and a pahoehoe and aa flow in the west-central part of the map. Consist of alkali olivine basalt with 1-3 percent plagioclase and less than 1 percent olivine phenocrysts.

R01S33 v_3 f_3 Small spatter cone and a pahoehoe and aa flow in the northwest part of the map. Consist of alkali olivine basalt with 1-3 percent plagioclase and 1-2 percent olivine phenocrysts.

Q96S33 v_3 f_3 Spatter cone and an aa and pahoehoe flow in the west-central part of the map. Consist of alkali olivine basalt with 1-3 percent plagioclase and less than 1 percent olivine phenocrysts.

Q96S30 v_3 Spatter deposits in the west-central part of the map. High-standing spatter is surrounded by f_3Q92S32. Adjacent pit crater may have formed initially during the eruption of v_3Q96S30, but it also transects f_3Q92S32. Consist of alkali olivine basalt with 4-8 percent olivine phenocrysts.

Q95S28 v_3 f_3 Spatter cone and aa and pahoehoe flows in the west-central part of the map. Consist of alkali olivine basalt with 1-3 percent olivine and less than 1 percent plagioclase phenocrysts.

Q91S52 v_3 f_3 Two small spatter and cinder cones in the west-central part of the map (500 m southeast of Kipahee), and an aa and pahoehoe flow. Consist of alkali olivine basalt with 4-8 percent plagioclase and less than 1 percent olivine phenocrysts.

Q90S55 v_3 f_3 Spatter cone and an aa and pahoehoe flow in the west-central part of the map (500 m south-southeast of Kipahee). Consist of alkali olivine basalt with 1-3 percent plagioclase phenocrysts.

Q97S41 v_3 f_3 Cone and a pahoehoe and aa flow in the west-central part of the map. Cone consists almost entirely of flows with very minor spatter. Consist of picritic alkali olivine basalt with 15-20 percent olivine phenocrysts.

Q89S36 v_3 f_3 Spatter cone and a pahoehoe and aa flow in the west-central part of the map. Consist of alkali olivine basalt with 6-10 percent olivine phenocrysts.

Q88S35 v_3 f_3 Spatter deposits and an aa and pahoehoe flow in the west-central part of the map. Consist of alkali olivine basalt with 2-4 percent olivine phenocrysts.

Q87S41 v_3 f_3 Spatter ramparts and pahoehoe flows in the west-central part of the map. Consist of alkali olivine basalt with 3-6 percent plagioclase phenocrysts.

Q88S40 v_3 Two small spatter cones in the west-central part of the map. Consist of alkali olivine basalt with 2-6 percent olivine phenocrysts.

Q73S29 v_3 f_3 Spatter deposits of Kauunuoku (southwest part of map) and five adjacent vents, and pahoehoe and minor aa flows. Consist of alkali olivine basalt with 3-6 percent olivine phenocrysts.

Q85S25 v_3 f_3 Spatter deposits that form four cones (three of which are Mailehahei, Puu Maau, and Kealoha) near the center of the map, and a large aa and pahoehoe flow. Consist of alkali olivine basalt with 10-20 percent olivine, 2-10 percent plagioclase, and 2-10 percent pyroxene phenocrysts and locally common xenoliths of gabbro.

R05R83 f_3 Aa flow in the northeast part of the map. Consists of alkali olivine basalt with 1-3 percent olivine phenocrysts in a locally feldspathic groundmass.

Q62S06 v_3 f_3 Spatter cone and a pahoehoe flow, with eight lava channels radiating from the cone, in the southeast part of the map. Consist of alkali olivine basalt with 1-2 percent olivine and less than 1 percent plagioclase phenocrysts.

Q56S18 v_3 f_3 Satellitic shield of Pohakuloa (south-central part of map), an associated small spatter deposit (v_3; shield is included in f_3), and pahoehoe and aa flows. Consist of alkali olivine basalt with 10-15 percent olivine phenocrysts.

Q98S70 v_3 f_3 Low, left-stepping en echelon spatter ramparts and short pahoehoe and aa flows near the west-central edge of the map; includes a small explosion crater that transects the north flank of Puu Honuaula (v_2Q92S73). Consist of alkali olivine basalt with 2-6 percent olivine, 0-2 percent plagioclase, and less than 1 percent pyroxene phenocrysts. 14C age is 3,990 ± 70 years (M. Rubin, written commun., 1982).

Q53S35 v_3 f_3 Spatter cone of Hinau (southwest part of map) and a pahoehoe flow. Consist of alkali olivine basalt with 4-8 percent olivine and 1-2 percent plagioclase phenocrysts.

Q68S39 f_3 Pahoehoe and aa flow in the southwest part of the map. Consists of alkali olivine basalt with 1-3 percent olivine phenocrysts.

R25S13 f_3 Pahoehoe flow near the north-central edge of the map. Consists of alkali olivine basalt with 1-2 percent olivine and less than 1 percent plagioclase phenocrysts.

R27S18 f_3 Aa flow in the north-central part of the map. Consists of alkali olivine basalt with less than 1 percent each of olivine and plagioclase phenocrysts.

UNITS 5,000-10,000 YEARS OLD

Q93S58 v_2 Spatter deposits in the west-central part of the map. Consist of alkali olivine basalt with 2-4 percent plagioclase and 1-2 percent olivine phenocrysts.

Q93S60 v_2 f_2 Spatter cone and an aa and pahoehoe flow in the west-central part of the map. Consist of alkali olivine basalt with 10-15 percent olivine phenocrysts. 14C age is 6,360 ± 100 years (M. Rubin, written commun., 1983).

Q68S57 v_2 f_2 Spatter rampart of Puu Hale (southwest part of map) and an aa and pahoehoe flow. Consist of alkali olivine basalt with 3-6 percent olivine, 1-3 percent plagioclase, and less than 1 percent pyroxene phenocrysts.

Q64S58 f_2 Aa and pahoehoe flow in the southwest part of the map. Consists of alkali olivine basalt with 2-4 percent plagioclase and 1-2 percent olivine phenocrysts.

Q99S69 v_2 Spatter deposits that form two adjoining cones 600 m north of Hainoa Crater, near the west-central edge of the map; two unmapped dikes of similar composition intrude the underlying v_2Q99S68 in the eastern crater. Consist of alkali olivine basalt with 3-6 percent plagioclase, 2-4 percent olivine, and less than 1 percent pyroxene phenocrysts and common xenoliths of gabbro.

Q99S68 v_2 Spatter deposits in the lower crater walls of the eastern cone (v_2Q99S69) 600 m north of Hainoa Crater (near west-central edge of map). Consist of alkali olivine basalt with 4-8 percent plagioclase and 1-2 percent olivine phenocrysts.

Q92S73 v_2 f_2 Spatter and cinder cone of Puu Honuaula (west-central edge of map) and an aa flow; flow is thickly mantled by rafted cinders and spatter. Consist of alkali olivine basalt with 5-10 percent olivine and less than 1 percent each of plagioclase and pyroxene phenocrysts.

Q92S63 v_2 f_2 Spatter deposits and aa and pahoehoe flows in the west-central part of the map. Consist of alkali olivine basalt, transitional to ankaramite, with 10-20 percent olivine and 5-10 percent pyroxene phenocrysts and abundant xenoliths of dunite, pyroxenite, and gabbro.

Q97S68 v_2 Spatter cone and unmapped dikes 200 m north of Hainoa Crater (near west-central edge of map). Consist of alkali olivine basalt with 3-6 percent olivine, 1-2 percent plagioclase, and less than 1 percent pyroxene phenocrysts. 14C age is 8,770 ± 200 years (M. Rubin, written commun., 1983).

Q60S50 f_2 Aa flow in the southwest part of the map. Consists of alkali olivine basalt with 1-3 percent plagioclase and less than 1 percent each of olivine and pyroxene phenocrysts.

Q48S43 f_2 Aa and pahoehoe flow in the southwest part of the map. Consists of alkali olivine basalt with 2-4 percent olivine, 1-2 percent plagioclase, and less than 1 percent pyroxene phenocrysts.

Q40S44 f_2 Aa flow in the southwest part of the map. Consists of alkali olivine basalt with 1-3 percent plagioclase and less than 1 percent each of olivine and pyroxene phenocrysts.

Q58S53 f_2 Aa and pahoehoe flow in the southwest part of the map. Consists of alkali olivine basalt with 1-3 percent olivine and 1-3 percent plagioclase phenocrysts.

Q57S28 f_2 Aa flow in the south-central part of the map. Consists of alkali olivine basalt with 2-4 percent olivine and 1-2 percent plagioclase phenocrysts.

Q50S25 v_2 f_2 Three spatter cones and associated aa flows in the south-central part of the map. Consist of alkali olivine basalt, transitional to hawaiite, with 5-10 percent plagioclase and 1-2 percent olivine phenocrysts.

Q52S28 f_2 Small aa flow in the south-central part of the map. Consists of alkali olivine basalt with 10-15 percent olivine phenocrysts.

Q65S09 v_2 f_2 Satellitic shield, consisting of pahoehoe flows, one unmapped dike, and associated spatter deposits, in the south-central part of the map. A deep (>120 m) pit crater formed near the end of the eruption; a small late-stage vent is visible near the bottom of the crater. Lava flows on the lower walls of the pit crater are inaccessible but appear similar to f_2Q78S28 in the large crater (v_4Q69S21) 1.3 km to the west-northwest. Consist of alkali olivine basalt with 1-2 percent olivine and less than 1 percent plagioclase phenocrysts.

Q80S27 v_2 f_2 Spatter rampart and a small pahoehoe flow near the center of the map. Consist of alkali olivine basalt with 4-8 percent olivine and 1-3 percent plagioclase phenocrysts.

Q78S28 v_2 f_2 Pahoehoe flows, with minor spatter deposits and aa, near the center of the map. Cones built at the two vents consist almost entirely of pahoehoe. Similar-appearing flows occur on the lower walls of two craters 1.3 and 2.5 km southeast of the vents. Consist of picritic alkali olivine basalt with 15-25 percent olivine phenocrysts.

R35S46 f_2 Aa flow at Shangri-la (northwest part of map). Consists of alkali olivine basalt with 8-12 percent olivine phenocrysts in a locally feldspathic groundmass.

R37S45 f_2 Aa flow on the east side of Potato Hill (northwest part of map). Consists of alkali olivine basalt with 6-10 percent plagioclase, 2-4 percent olivine, and less than 1 percent pyroxene phenocrysts and scattered xenoliths of gabbro.

Q88R86 f_2 Aa and pahoehoe flow in the east-central part of the map. Consists of alkali olivine basalt with 3-5 percent olivine phenocrysts.

Q87R93 f_2 Pahoehoe flow in the east-central part of the map. Consists of alkali olivine basalt with 5-10 percent olivine phenocrysts in a feldspathic groundmass.

Q64R89 f_2 Aa and pahoehoe flow in the east-central part of the map. Consists of alkali olivine basalt with 2-4 percent olivine and 1-3 percent plagioclase phenocrysts.

Q71R85 f_2 Aa flow in the east-central part of the map. Consists of alkali olivine basalt with 3-6 percent plagioclase, 1-3 percent olivine, and less than 1 percent pyroxene phenocrysts.

Q92S47 v_2 f_2 Spatter cone and an aa and pahoehoe flow in the west-central part of the map. Consist of alkali olivine basalt with 15-20 percent olivine, 1-2 percent pyroxene, and less than 1 percent plagioclase phenocrysts and common xenoliths of gabbro, pyroxenite, and dunite.

Q76S58 v_2 f_2 Spatter cone of Puu Nenaakolu (southwest part of map) and an aa and pahoehoe flow. Consist of alkali olivine basalt with 3-6 percent olivine phenocrysts.

Q33S42 v_2 f_2 Spatter cone of Pihapono (southwest part of map) and a pahoehoe flow. Consist of alkali olivine basalt with 6-12 percent olivine and less than 1 percent plagioclase phenocrysts.

Q98S61 v_2 f_2 Spatter cone and a small pahoehoe flow, confined within the cone, near the west-central edge of the map. Consist of picritic alkali olivine basalt with 15-20 percent olivine and less than 1 percent each of pyroxene and plagioclase phenocrysts; scattered xenoliths of gabbro are present.

Q32S18 v_2 f_2 Spatter cone of Puu Ikaaka (near south-central edge of map) and an aa and pahoehoe flow; flow is thickly mantled by cinders and spatter rafted from the vent. Consist of alkali olivine basalt, transitional to ankaramite, with 15-20 percent olivine, 5-10 percent pyroxene, and less than 1 percent plagioclase phenocrysts. Xenoliths of dunite and minor pyroxenite and gabbro are abundant.

R05S17 v_2 f_2 Spatter cone of Puu Nahaha (north-central part of map) and a pahoehoe and aa flow. Consist of alkali olivine basalt with 5-10 percent olivine phenocrysts.

Q98S25 v_2 Small spatter cone near the center of the map. Consists of alkali olivine basalt with 3-6 percent olivine phenocrysts.

R27R78 f_2 Pahoehoe flow in the northeast part of the map. Consists of alkali olivine basalt with 10-15 percent olivine phenocrysts.

Q77S20 v_2 Small spatter cone near the center of the map. Consists of alkali olivine basalt with 3-6 percent olivine phenocrysts.

R42R88 f_2 Aa flow in the northeast part of the map. Consists of alkali olivine basalt with 1-2 percent olivine and less than 1 percent plagioclase phenocrysts.

Q40S07 v_2 Small spatter cone in the south-central part of the map. Consists of alkali olivine basalt with 2-4 percent plagioclase and less than 1 percent olivine phenocrysts.

Q34S02 v_2 Spatter cone in the southeast part of the map. Consists of alkali olivine basalt with 3-6 percent plagioclase and 1-3 percent olivine phenocrysts.

Q28S03 v_2 Spatter cone near the south edge of the map. Consists of alkali olivine basalt with 4-8 percent plagioclase and less than 1 percent olivine phenocrysts.

Q95S53 v_2 Small cinder and spatter cone 200 m east of Kipahee, in the west-central part of the map. Consists of alkali olivine basalt with 2-4 percent olivine, 1-3 percent plagioclase, and less than 1 percent pyroxene phenocrysts.

Q95S61 v_2 f_2 Small spatter rampart and an aa flow in the west-central part of the map. Consists of alkali olivine basalt with 3-6 percent plagioclase and 1-2 percent olivine phenocrysts.

Q69S13 v_2 Spatter cone in the south-central part of the map. Consists of picritic alkali olivine basalt with 15-20 percent olivine and 1-2 percent pyroxene phenocrysts.

R42R77 f_2 Small pahoehoe flow in the northeast part of the map. Consists of alkali olivine basalt with 5-10 percent olivine and 1-3 percent plagioclase phenocrysts.

R13R82 f_2 Small aa flow in the northeast part of the map. Consists of alkali olivine basalt with 8-15 percent olivine, 3-6 percent plagioclase, and 1-3 percent pyroxene phenocrysts and scattered xenoliths of gabbro.

UNITS MORE THAN 10,000 YEARS OLD

Q87S74 v_1 Spatter cone near the west-central edge of the map. Consists of alkali olivine basalt with 5-10 percent olivine, 3-6 percent pyroxene, and 1-3 percent plagioclase phenocrysts.

Q74S05 v_1 Spatter cone near the center of the map. Consists of alkali olivine basalt with 2-5 percent olivine phenocrysts.

Q65S37 v_1 Small spatter and cinder cone in the southwest part of the map. Consists of alkali olivine basalt with 3-6 percent plagioclase and 1-2 percent olivine phenocrysts.

R40S45 v_1 Cinder and spatter cone of Potato Hill (northwest part of map). Consists of alkali olivine basalt with 2-4 percent olivine phenocrysts.

Q55S47 v_1 Spatter cone in the southwest part of the map. Consists of alkali olivine basalt with 2-4 percent olivine phenocrysts.

Q38S33 v_1 Two small spatter cones in the southwest part of the map. Consist of alkali olivine basalt with 4-8 percent olivine phenocrysts.

MAUNA LOA VOLCANO

UNITS LESS THAN 1,000 YEARS OLD

Q52R50 f_5 Pahoehoe and aa flows, erupted in A.D. 1859 (Stearns and Macdonald, 1946)(east edge of map). Consist of tholeiitic basalt with 1-3 percent olivine phenocrysts.

Q28R50 f_5 Pahoehoe flow in the southeast part of the map. Consists of tholeiitic basalt with 5-10 percent olivine phenocrysts in a feldspathic groundmass. 14C age is 1,150 ± 200 years (M. Rubin, written commun., 1985); flow overlies a Hualalai flow (f_5Q48S12) dated at 900 ± 110 years, so both flows probably were erupted about 1,000 years ago.

UNITS 1,000-3,000 YEARS OLD

Q26R76 f_4 Pahoehoe flow near the southeast edge of the map. Consists of tholeiitic basalt with 1 percent olivine phenocrysts in a locally feldspathic groundmass. Flow overlies Hualalai flow f_4Q69S21, which is dated at 1,180 ± 200 years.

R38R50 f_4 Aa flow in the northeast corner of the map. Consists of tholeiitic basalt with 1-3 percent olivine phenocrysts and rare xenoliths of troctolite.

UNITS 3,000-5,000 YEARS OLD

Q58R50 f_3 Large pahoehoe flow, locally with very minor aa, in the east and northeast parts of the map. Flow is dense, vesicle-poor, and characterized by a rind of surficial glass 1-6 cm thick. Consists of tholeiitic basalt generally with 2-4 percent olivine phenocrysts in a locally feldspathic groundmass; rarely, the flow contains lenses with as much as 10-15 percent olivine phenocrysts.

Q25R50 f_3 Pahoehoe flow near the southeast corner of the map. Consists of generally picritic tholeiitic basalt with 10-25 percent olivine phenocrysts in a locally feldspathic groundmass.

R23R50 f_3 Pahoehoe and aa flow in the northeast part of the map. Consists of picritic tholeiitic basalt with 15-25 percent olivine and 5-10 percent plagioclase phenocrysts.

Q33R50 f_3 Pahoehoe flow, locally with minor aa, along the east edge of the map. Consists of picritic tholeiitic basalt with 15-25 percent olivine phenocrysts.

Q55R50 f_3 Aa and pahoehoe flow at Halelaau (near southeast edge of map). Flow is deeply weathered and stained reddish-brown. Consists of picritic tholeiitic basalt with 15-25 percent olivine and 5-10 percent plagioclase phenocrysts.

Q53R52 f_3 Pahoehoe flow at Halelaau (near southeast edge of map). Consists of tholeiitic basalt with 3-6 percent olivine phenocrysts in a locally feldspathic groundmass.

R45R64 f_3 Pahoehoe flow in three small kipukas near the northeast corner of the map. Consists of tholeiitic basalt with 4-8 percent olivine and 2-6 percent plagioclase phenocrysts.

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GEOLOGIC MAP SYMBOLS

f=flow, v=vent deposit, t=tuff
Subscript (1-5) indicates relative age classification: 5=<1,000 years old; 4=1,000-3,000 years old; 3=3,000-5,000 years old; 2=5,000-10,000 years old; 1=>10,000 years old

A six-character symbol consisting of a letter plus two digits followed by a second letter and two more digits is a unique geographic identifier for each vent deposit and its related flows. The pair of letter-digit-digit combinations represents a pair of coordinates on an island-wide grid based on latitude and longitude (E.W. Wolfe and C.A. Neal, written commun., 1985). The letters represent 6-minute intervals in the grid. In the Hualalai quadrangle, Q or R in the first position correspond, respectively, to latitude 19°36' and 19°42' or 19.6° and 19.7°. Similarly, R or S in the fourth position correspond, respectively, to longitude 155°42' and 155°48' or 155.7° and 155.8°. The two numbers that follow each letter correspond to hundredths and thousandths of degrees. Thus, the identifier Q48S12 refers to a grid position at latitude 19.648° and longitude 155.812°. The identifier for flows that cannot be traced to vents within the Hualalai quadrangle is chosen arbitrarily to represent the grid position within the quadrangle or the part of the flow closest to the axis of Hualalai's major south-southeast-trending rift zone.

Each volcanic map unit is the product of a brief geologic event. In the absence of 14C ages (there are only 13 for the Hualalai quadrangle), there is no certainty about the absolute age of a map unit. The units are included in chronostratigraphic groups on the bases of field stratigraphic relationships, the few 14C ages, amount of soil development, and degree of degradation of surface glass and primary flow features. A bracket on the correlation chart (except for the large bracket with diagonal lines distinguishing the Mauna Loa flows) indicates the possible age range of any unit or sequence of units. Stratigraphic relationships are indicated by the vertical placement on the correlation chart.

——	Contact, approximately located
×	Location and age of 14C-dated charcoal sample (M. Rubin, written commun., 1978-1985)
	Geology mapped 1980-1985
o/y	Relatively older and younger units, at location where relationship is demonstrable
✓✓	Pattern on Mauna Loa flows

PRELIMINARY GEOLOGIC MAP OF THE HUALALAI QUADRANGLE, HAWAII

by Richard B. Moore, Frank A. Trusdell, David A. Clague, and Wendy A. Bohrson

1986

This report is preliminary and has not been reviewed for conformity with U.S. Geological Survey editorial standards and stratigraphic nomenclature.